The Immune Response

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The immune system has at least three major functional properties that distinguish it from all of the body's other defenses. The first is its extreme **specificity**—the ability to recognize and distinguish among a vast number of different target molecules and to respond (or not respond) to each of these individually. Second, the immune system **discriminates between self and nonself**, so that it normally coexists peacefully with all of the innumerable proteins and other organic materials that make up the host but responds vigorously against foreign substances, including cells or tissues from other people. Third, the immune system has **memory**, that is, the ability to be molded by its experiences so that subsequent encounters with a particular foreign pathogen provoke more rapid and more vigorous responses than occurred at the initial encounter.

These properties of the immune system seemed impenetrable mysteries only a few decades ago, but in recent years they have begun to yield to research. A great deal is now understood about the mechanisms that give rise to immunologic specificity and memory, and the processes underlying self–nonself discrimination are beginning to be unraveled as well. What has emerged is the realization that the lymphocyte population in each person constitutes an extraordinarily interactive network of mobile cells that are almost as diverse as the foreign substances they respond to and that their diversity is the result of molecular genetic processes that may well be unique to these cells. Moreover, it is now recognized that each person's immune system is continually evolving in response to its environment and experience as the individual cells communicate and cooperate with one another to control their own proliferation, differentiation, and immunologic functions.

The interplay of molecular and cellular events that takes place during even the simplest immune response is dauntingly complex, and many aspects of immune system function are still incompletely understood. As a result, the subject can be especially bewildering and intimidating on first encounter. The goal of this chapter is therefore to present an introduction to the subject by describing the organization of lymphocyte populations and the essential elements of an immune response in a stepwise and simplified fashion. Each of these topics will then be addressed more rigorously and in much greater detail in subsequent chapters of this book.

CLONAL ORGANIZATION & DYNAMICS OF LYMPHOCYTE POPULATIONS

Virgin lymphocytes are continually released from the primary lymphoid organs into the periphery, each carrying surface receptors that enable it to bind substances called **antigens**. Antigen binding in B cells is mediated by surface immunoglobulin proteins, whereas in T cells it is mediated by T-cell receptors. The sequences of these two types of proteins are extremely diverse, so that as a group they can bind an enormous variety of antigens (see Chapters 7 and 9). Antigen binding, when accompanied by other stimuli, can lead to activation of a T or B cell. Virgin lymphocytes that fail to become activated die within a few days after entering the periphery, but those that become activated survive and proliferate, yielding daughter cells that may then undergo further cycles of activation and proliferation.

All of the progeny cells derived from any single virgin lymphocyte constitute a lymphocyte **clone**. Some members of each clone differentiate into effector cells, whereas the remainder are memory cells; however, apart from this, all cells within a clone are identical to one another in nearly all respects, reflecting their common ancestry. For example, B-cell clones contain only B cells, and each T-cell clone is made up entirely of either CD4+ or CD8+ cells.

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a LANGE medical book

Medical Immunology

ninth edition

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97 98 99 00 01 / 10 9 8 7 6 5 4 3 2 1

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Prentice Hall of Australia Pty. Limited, *Sydney*
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Prentice Hall of India Private Limited, *New Delhi*
Prentice Hall of Japan, Inc., *Tokyo*
Simon & Schuster Asia Pte. Ltd., *Singapore*
Editora Prentice Hall do Brasil Ltda., *Rio de Janeiro*
Prentice Hall, *Upper Saddle River, New Jersey*

ISSN 0891-2076

ISBN 0-8385-0586-4

Acquisitions Editor: John Butler
Production Service: Rainbow Graphics, Inc.
Associate Art Manager: Maggie Belis Darrow
Designer: Libby Schmitz

PRINTED IN THE UNITED STATES OF AMERICA